

In recent years, EPA has been moving beyond environmental regulation to environmental protection in a broader sense, anticipating and preventing problems before they mushroom into major concerns. To support EPA in this endeavor, ORD conducts research on 'Emerging Issues,' anticipatory activities that fall within the mission of EPA, but are not being addressed in ORD's major research programs. Two such issues are endocrine-disrupting chemicals and environmental socioeconomic values.

pesticides and industrial chemicals, are either known or suspected EDCs.

ORD is a world leader in EDC research.

Because of the global scope of the EDC problem, the possibility of serious problems in humans and wildlife, and the persistence of some EDCs in the environment, research on EDCs is a high priority at ORD. ORD leads an international committee that is conducting a

Emerging Issues

ENDOCRINE-DISRUPTING CHEMICALS

In the last decade, the scientific community has become increasingly concerned that humans experience health problems and wildlife populations are adversely affected following exposure to chemicals that interact with the endocrine (hormonal) system. The endocrine system plays a critical role in normal growth, development, reproduction, and behavior. Disruptions in hormonal balance at critical life stages may have long-lasting effects. Chemicals that interfere with the function of the body's natural hormones are called endocrine-disrupting chemicals (EDCs). A broad range of environmental contaminants, including some

global state-of-the-science assessment of EDCs and a national working group that coordinates EDC research among multiple federal agencies. ORD's multidisciplinary EDC research addresses critical gaps in our understanding of how people and wildlife are exposed to EDCs in the environment and the health and ecological effects of such exposures. The information gained in this research program will directly support EPA risk assessments and risk management activities.

EDC Screening and Testing

The Food Quality Protection Act and Safe Drinking Water Act Amendments mandate that

EPA develop an EDC screening and testing program to evaluate chemicals found in food and drinking water. EPA's Endocrine Disruptor Screening Program develops and validates



ORD scientists have developed a screening test using fathead minnows that identifies reproductive disruptions resulting from exposure to chemicals.

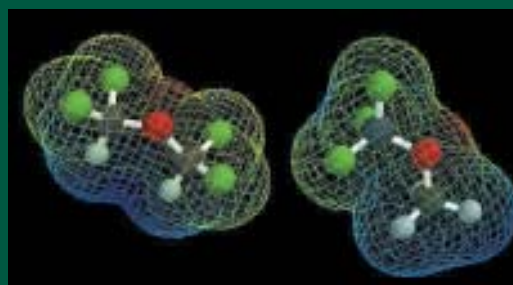
methods and procedures used to detect and characterize the endocrine-disrupting activity of pesticides, industrial chemicals, and environmental contaminants. These protocols will help EPA and industry efficiently gather information regarding endocrine-disrupting activity for the estimated 87,000 chemicals in commercial use.

ORD scientists play a major role in developing these testing protocols. As of 2001,

ORD researchers have developed or are developing

- protocols to identify chemicals that change the age of puberty in male and female rats,
- screening tests to identify substances that mimic or interfere with male hormones,
- methods to assess the effects of chemicals on reproduction and on pre- and postnatal development in mammals,
- procedures for detecting chemically induced reproductive problems in fish and invertebrate animals, and
- tests to identify chemicals that interact with locations in cells where hormones bind to cells.

In addition to laboratory tests, ORD scientists are developing computer models that predict a chemical's effect on biological systems based on its molecular structure. These models will provide a means to rapidly and cost-effectively screen large numbers of chemicals for structural features likely to be associated with endocrine-disrupting activity. Chemicals identified by these models as possible EDCs can then be evaluated using one of the biological screening methods listed above.



These three-dimensional diagrams show the structural similarity between two compounds. When a structural characteristic is associated with endocrine-disrupting activity, a computer model can be used to identify other compounds with similar structural features.

EDC Toxicology

A major area of ORD research addresses chemicals that either mimic, enhance, or block the action of male hormones. Chemicals that exhibit any of these effects include phthalate esters (used widely in the manufacture of plastics) and several pesticides. When exposed to these chemicals, laboratory animals have developed numerous developmental problems including undescended testes, malformation or lack of sexual organs, and cancer-like testicular lesions.

In 1999, ORD investigators reported that exposure of pregnant and nursing rats to atrazine, a widely used agricultural herbicide, increased the risk that male offspring would suffer from inflammation of the prostate gland as adults. In 2000-2001, ORD toxicologists used two of the newly developed screening protocols to determine that atrazine delayed the onset of puberty in both male and female rats. Using the same protocols and an expanded range of doses, ORD scientists were able to characterize the relationship between dose and response for this toxic effect, an ability that had not been anticipated when

An ORD toxicologist conducting research.



the protocols were developed. EPA's Office of Pesticide Programs incorporated the results from this research on atrazine into the latest human health risk assessment, which was used to determine the level of atrazine residue permitted in foods.

Both ORD toxicology and epidemiology studies have found that exposure to EDCs can alter the age at which puberty is reached.

EDC Epidemiology

In 2000, scientists working under EPA's Science to Achieve Results (STAR) grant program reported results of an epidemiologic study on the effect of polybrominated biphenyl (PBB) on the age at which girls reach puberty. Following an industrial accident in Michigan in which a PBB-containing fire retardant was inadvertently added to livestock feed, health authorities established a registry of residents exposed to meat and dairy products contaminated with PBB. Daughters of



women listed in this registry who were born during or shortly after the incident were eligible for the study. The researchers found that breastfed girls exposed to high levels of PBB before birth were approximately six to twelve months younger when they started their periods than breastfed girls exposed to lower PBB levels before birth or girls who were not breastfed.

EDC Risk Management

ORD recently launched a new risk management research activity focusing on several types of compounds that are known or suspected EDCs. A team of scientists from ORD and EPA's program offices are collaborating with outside researchers to address two major questions:

- *Can the application of currently available risk management tools successfully manage the risk of exposure to EDCs in a cost-effective manner?*
- *As more information about EDCs becomes available, what new tools will we need to manage the risks associated with exposure to EDCs?*

This research program includes scientists

within and outside of ORD and EPA who are laying the groundwork for future research in this area. Recent accomplishments include publication of *Removal of Endocrine Disruptor Chemicals During Drinking Water Treatment*, completion of the draft document *Risk Management Evaluation of Endocrine Disrupting Chemicals*, and coordination of a workshop where experts identified and evaluated effective risk management strategies for EDCs.

ENVIRONMENTAL SOCIOECONOMIC VALUES

While of undeniable benefit to the nation's citizens, virtually all regulatory activities impose costs on the public. Understanding how to evaluate the costs and benefits associated with environmental decision making is another emerging research area at EPA.

Eliciting an individual's true preferences is one of the most important features of survey design.

Working under a STAR grant administered by ORD, a researcher at the University of California–San Diego studied various survey formats that are used to assign an economic value to environmental assets such as clean air, clean water, and the cleanup of sites contaminated with toxic or hazardous substances. The research explored incentive-

compatible preference surveys, which are designed to provide survey participants with incentives to truthfully and fully reveal their preferences on the subject of the survey. EPA is using the findings of this research to develop a handbook for agencies and organizations that conduct preference surveys on environmental issues. For instance, these types of surveys can be used to assign economic value to environmental resources—such as wilderness areas and haze-free vistas at scenic locations—and policies that protect human health, such as air pollution control regulations. This new information can help EPA and state policy analysts evaluate and articulate the costs and benefits of environmental programs.

LOOKING TO THE FUTURE

Anticipated accomplishments in ORD's research on emerging environmental issues include

- *new and improved biological and computational screens and tests for EPA's EDC screening and testing program;*
- *a better understanding of the impact of EDC exposures during development on the onset and severity of health problems later in life;*
- *an evaluation of the usefulness of fish, reptile, and bird species as indicators of the presence of EDCs in the environment; and*
- *a determination of the extent of sources—such as combustion operations, animal feedlots, and wastewater treatment plants—that can expose people to EDCs.*



A socioeconomic survey investigating environmental values might ask questions designed to determine how much value respondents place on a clear view versus a view that is hazy due to air pollution.



